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Exploring the Challenges and Opportunities of BIM Implementation in Major Architectural Projects in Iraq

Munaf Fouad Hassan[1*], Sajeda Kadhum Al-Kindy[2]

[1] Construction and Projects Department, University of Warith Al-Anbiyaa, Karbala 56001, Iraq
[2] Department of Architecture, University of Baghdad, Baghdad 10071, Iraq

Corresponding Author Email: munaf.albayati@uowa.edu.iq

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ABSTRACT

The economic, environmental, and societal impact of major architectural projects highlights the need to study the challenges that affect their performance and completion. Building Information Modeling (BIM) is a critical tool for enhancing project completion in the AEC field and has been widely used globally, especially in major projects. This research aims to explore the application status of BIM in major architectural projects in Iraq and investigate the reasons behind its limited use. The research methodology involves conducting interviews with specialists and using designed questionnaires to gather feedback from clients, consultants, contractors, and BIM practitioners. Several Iraqi major projects that implement BIM technology are selected as case studies. The research findings reveal that BIM application levels in the design and construction of major projects in Iraq are limited due to several reasons, with the main reason being the lack of government and private institutions' requirements for BIM application in their project designs and construction. This study on BIM's role and application obstacles in major projects in Iraq will serve as a guide for managers and practitioners to determine the appropriate "Level of Detailing" based on project characteristics and integration limits, enabling better benefits for owners and stakeholders.

1. INTRODUCTION

The application of digital information technologies in the construction industry creates a favorable environment for the establishment and expansion of businesses that focus on the use of technology in architecture and construction [1].

Building Information Modeling is a teamwork method based on digital technology that makes managing, delivering, and planning physically built assets more effective. BIM technology improves the capability of analysis, control, and change over previous manual techniques by utilizing an accurate virtual model of the building.

BIM is used by architects and construction engineers to produce 3D models of a finished, furnished building using programs like Graphisoft Archicad, Bentley MicroStation, Autodesk Revit, and Allplan (Nemetschek Group). BIM, however, is not a tool for design or visualization. It is a procedure that makes it possible to develop a common data model. All parties involved, including the building's designers, the construction business, and finally the property owners and managers, have access to this model.

To coordinate and communicate, the project delivery process has always been disjointed and dependent on 2D drawings where errors and omissions in paper documents can cause unanticipated field expenses, delays, and conflict among project team members.

These issues frequently result in delays, conflicts, and financial costs, especially in major projects which are simply more than being enlarged copies of minor projects as they are consisting of entities that incorporate a collection of systems and functions with varying degrees of complexity, ambiguity, dangers, and multiplicity of components.

A more effective and integrated design can be achieved through the professional implementation of BIM, and this is reflected in the project construction process. Buildings are expected to be of a high standard, less in cost, and take less time to construct. In addition to overseeing the project's physical assets, it can also improve the efficiency and adaptability of future maintenance tasks. A critical issue related to BIM comprehension is the project manager's responsibility.

Building information modeling has affected many aspects of the construction industry, and governments worldwide have legislated to allow its use. In this regard, Ingram [2] refers to the spread of BIM by stating, “Most large buildings worldwide have been designed and built using BIM while saving more than US$1 trillion worldwide by 2025.”

The advantages of BIM are cumulative throughout the duration of a project, with design and preconstruction advantages directly improving the quality of the finished product [3].

It is challenging to finish the majority of construction projects at the greatest level of performance because of the risky nature of the sector and the numerous internal and external factors that might influence the construction process, which eventually results in cost inflation [4]. The construction manager must take into account new tools, procedures, and abilities.

BIM makes it simple for managers to exchange information from the design team with the main contractor and

subcontractors, and then with the owner or operator [5].

This lowers costs and gives the owner more information that is easy to grasp. The management's usage of BIM models is demanding and an effort to cut costs and quickly settle departmental disagreements. Construction project management and scheduling are made easier with the use of BIM for cost estimates and time in the BIM process.

This research structure is based on a literature survey to investigate and extract the contribution of BIM in project planning and execution and the BIM's role in coordinating works and avoiding design and construction errors. The main factors affecting BIM application will be set based on interviews with specialists and replies to the designed questionnaires. To cross-check data regarding BIM benefits, some major projects in Iraq were selected as case studies whereby interviews had taken place with specialists and design managers.

2. PROBLEM STATEMENT

Major architectural projects are characterized by their large size, high cost, complexities, uncertainties, high risk, and other specific features. The major projects experience a serious need for the introduction of ICT in the design and construction for higher integration and coordination of the multi-disciplinary engineering systems which makes these technologies a considerable factor in extending the success chances of projects when applied properly. There is a lack of research studying the status of Building Information Modelling applications, their level of detailing, and obstacles confronting integrated applications in the design and construction of these major projects in Iraq.

3. LITERATURE REVIEW

BIM technology application had a positive influence on project performance, cost, and time when the right environment, stakeholders, and resources are available in an integrated arrangement.

Because of the benefits shown by the use of BIM in the projects of several countries, many of these countries have introduced instructions and laws requiring the application of BIM in the design and construction of engineering projects.

Despite these benefits, the difficulties that prevent its application in many other countries still exist for several reasons. For example, BIM application benefits can be gained when the project processes are all complementary, i.e., when the design is accomplished under BIM and the contractors have the qualification and ability to deal with it and build the next required deliverables such as shop drawings (if not done), the cost and schedules, and the as-built drawings. This issue hampers the application of BIM by consultants in case of contractors' non-capability to work within a BIM environment. Besides, clients and owners and their representative managers are the decision makers, so in case they don't realize the need for BIM and to what extent it can be beneficial, it will not be applied especially when it is not requested as a condition to be adhered to by consultants and contractors.

3.1 BIM in International major projects

BIM had been adopted in many international projects in its integrated form. The fourth-dimension model had been used as an additional dimension in scheduling, project phase simulation, and theoretical stabilization of interim payments.

Besides, the fifth-dimension model is used in managing costs through real-time conceptual modeling, raising quantities to support cost details, ensuring business procedures from the manufacturing model and supplier data and their conformity to specifications as well, as applying value engineering, pre-processing, and expressing the supply chain. The followings are some international projects that applied BIM effectively:

A- In South Korea, Dongdaemun Design Plaza (DDP), is regarded as the first large project to utilize BIM during the planning and building stages. The project is designed by Zaha Hadid and it launched in 2014. Both the schedule and the cost were substantially increased from the initial plan. The project team has decided that, despite the expenses and time involved, it cannot be finished without the use of BIM. For its use of cutting-edge technologies and its intricate shapes, the DDP merits consideration as a BIM case study.

B- "National Children's Hospital, Dublin-Ireland", where BIM-level-2 was demanded and adopted starting from the concept stage.

C- "Hyundai Motor Studio, Goyang, South Korea, used BIM at the design stage whereby the design and construction problems have been solved.

D- Carlton Gate, PRP Architects - London in 1986/1987. PRP was one of the first architectural firms to adopt Building Information Modeling (BIM).

E- In Medina, Saudi Arabia's "Prince Mohammad Bin Abdul-Aziz International Airport" has been recognized as the first LEED Gold airport in the Middle East and North Africa area. To ensure that "BIM models are maintained and that BIM models generated for future projects, from small interior alterations to new expansions to new buildings inside the airport, are consistent with the BIM-FM platform," a thorough FM/operations BIM execution plan was required. Better analytics and performance for operations, energy management, business, and beyond are the results of using BIM as a platform to merge existing FM systems, such as "the Computerized Maintenance Management System (CMMS) and Building Management/Automation System (BMS/BAS)." (ibid).

Some users in the Arab region apply BIM as a tool for specific purposes and not as an integrated process. However, some Arab countries have taken some important steps to promote BIM as an integral part of the project management process. Knowledge of this concept and its application in many Arab countries is still limited and has not improved clearly.

3.2 BIM in Iraqi projects

The vast majority of construction projects in developing countries have not utilized BIM across the entire development cycle [6]. BIM technology has generally been included in just a limited number of major projects in Iraq. Here are some examples of research and projects:

A- According to Hamada et al. [7], BIM technology has been adopted in some major projects in Iraq.

Based on his research, the introduction of foreign companies to Iraq resulted in the development of BIM. These companies were hired to design and build some major projects like the Sports City in Basra (Figure 1), the Mina Stadium

(Figure 2), and the Najaf Teaching Hospital.

Figure 1. Sports City project in Basra

These projects were successful in reducing costs and time as well as preventing design and construction conflicts. "360 Architecture of Kansas City" is the consultant for the Basra Main Stadium. The project consists of a 2.5 million square feet site. The main stadium in Basra can hold 65,000 spectators, and its exterior is made of fiberglass-reinforced plastic panels. The building process started on July 15, 2009, and was finished on October 12, 2013. The project cost was roughly $550 million. Another large building in Basra is the 30,000-seat Al Mina Stadium. It was created by the American firm 360 Architects, and construction on it cost 86 million dollars and lasted from 2011 to 2013.

Figure 2. Mina Stadium project in Basra

B- Erzaij and Obaid [8] target to find out the advantages of BIM technology that allow convincing clients and stakeholders to adopt BIM in the field of engineering and construction in Iraq. Where the researcher relied on creating a framework for the BIM application through the Revit application and linking it with Navisworks Manage and with the MS project.

C- The research conducted by Al-Zwainy et al. [9] aims to identify and evaluate the advantages and disadvantages of BIM in construction project management. The report claims that there is a certain level of responsiveness of (BIM) in Iraq, which is anticipated to grow over the next few years.

D- According to Hatem et al. [10], the barriers to adopting BIM in Iraqi building projects are, ineffective government initiatives and a lack of enthusiasm for carrying them out; A scarcity of BIM professionals, and a lack of awareness of the advantages of BIM; Change-resistance, and Sub-standard education and training.

E-Through their research, Alsaeedi et al. [11] have identified obstacles to achieving the anticipated benefits of using BIM in projects, including the fact that industrial practitioners are not engaged in BIM applications and have insufficient BIM expertise with businesses. The researcher concludes that the phenomenon of reluctance and not accepting change from the beginning is one of the most significant reasons for not applying BIM widely, especially given the presence of a small number of those who apply BIM, their experience ranging from 3-to-6 years only. Because there is no administrative mandate or legislation requiring the use of BIM in projects, as there are in many developed nations and some regional nations, the researcher believes that the construction industry in Iraq is still not ready to invest in BIM and that many engineers still prefer the traditional methods of project design.

F- Saber and Wali [12] concentrated on the challenges that BIM implementation faces in the construction industry in northern Iraq. The study concluded that the lack of training for BIM applications in government departments, the absence of legislation requiring BIM applications on consulting firms, and the lack of university curricula about programs related to the BIM environment such as ArchiCAD and Revit are the most significant factors affecting the application of BIM in northern Iraq.

Therefore transitioning to BIM from a traditional drawing environment involves several risks and problems. In this regard, numerous studies have been conducted to examine the difficulties in setting up and maintaining a BIM-based system.

4. RESEARCH METHODOLOGY

The reality of physical objects and practical aspects of architectural projects calls for the adoption of a positive philosophy that calls for dealing with "facts", such as achieving project goals or realizing the benefit provided by the use of BIM, for example, in the project. Interpretations of these facts can be varied as long as there is a basic objective "truth", but its interpretation is individual, which calls for a combination of positive and explanatory philosophies.

Consulting and contracting companies apply different project management tools and methods, as these projects are affected by multiple social, cultural, environmental, and human factors. Therefore, the adoption of a research method that combines "quantitative and qualitative methods" is a more comprehensive method of addressing the subject of the research.

This study is based on both qualitative and quantitative research and took into account both subjective and objective viewpoints. In collecting primary data, the research relied on interviews and questionnaires for specialists and practitioners of BIM applications in projects. Interviews and questionnaires combine the qualitative and quantitative approaches to the study, and the analysis of both approaches enables the researcher to touch the most realistic results.

Six BIM experts in consulting firms and constructing companies are selected and consulted regarding the (21) factors that are collected from the literature survey and shown in Table 1. The discussion and analysis of these factors lead to the conclusion that they can be merged into (7) main factors, shown in Table 2, which are expected to be verified and realized by respondents easier than the 21 factors. These factors are arranged in a designed questionnaire using Google Forms and distributed via mail whereas others were handed over as hard copies as per respondents' request.

Table 1. Classification of extracted factors affecting BIM adoption in Iraqi major projects

Proposed main categories of factors acting as obstacles against BIM adoption			
A	Financial	C	Organizational
A-1	Ability to purchase new BIM devices and software	C-1	Possibility of BIM software training for company employees
A-2	The high price of BIM tool training	C-2	Insufficiently qualified staff
A-3	Lack of understanding of the business benefits of BIM	C-3	Opposition to change
A-4	limits imposed by the employer due to the high cost	C-4	The necessity of defining the "BIM director" function in projects
A-5	Time invested in applying BIM	C-5	Reorganizing the business to adopt the BIM philosophy
A-6	Cost of modeling Production time for the model	C-6	The requirement for standard specifications
B	Technical	C-7	The absence of effective contract documentation
B-1	Lack of knowledge regarding BIM technology	C-8	Reorient the workplace culture to emphasize full collaboration
B-2	The challenge of learning	D	External
B-3	The requirement for compatibility in the design's digital data	D-1	Lack of ownership demand
B-4	Program inefficiency in data interchange and internal cooperation	D-2	Absence of government assistance
		D-3	The shortfall of BIM applications

Table 2. Factors affecting BIM application in major architectural projects in Iraq

	Factors affecting BIM application	**Level of Impact**					**ΣW**	**RII %**	**Mean**	**S.D.**	**Rank**
		1	**2**	**3**	**4**	**5**					
X1	lack of sufficient knowledge of the institutions, companies, and public and private organizations about what BIM is and how it is applied	0	2	27	56	80	165	82.50	4.125	0.853	2
X2	The absence of integrated local practices and applications for BIM that can demonstrate its feasibility	0	2	36	56	65	159	79.50	3.975	0.862	3
X3	The reluctance and hesitation of many consultants and contractors to the idea of switching to BIM	4	8	27	56	45	140	70.00	3.50	1.240	5
X4	The idea among many practitioners that what BIM achieves is not very different from CAD and that the current supporting tools and software are sufficient	4	10	36	48	35	133	66.50	3.325	1.206	6
X5	The benefits of BIM application may not match the costs and time that institutions and companies need to apply BIM professionally	5	20	33	40	20	118	59.00	2.95	1.197	7
X6	Government and private institutions do not stipulate the application of BIM in the design and construction work of their projects	0	4	21	36	110	171	85.50	4.275	0.933	1
X7	The lack of contracts that take into account the characteristics of BIM applications in consulting services and construction and maintenance work	0	10	30	52	60	152	76.00	3.80	1.018	4

Fifty-five questionnaires had been distributed to project managers and engineers in different positions to get their replies regarding the adoption of BIM in the projects they had participated in Iraq.

Respondents were asked to select the impact level according to the proposed (5) level percentages which are (10%, 30%, 50%, 70%, and 90%). These percentages are reflecting the impact level of each factor from respondent experience and viewpoint. They are respectively: (very low impact, low impact, medium impact, high impact, and very high impact).

Forty-seven replies had been received and seven of them had been neglected for being noncompleted. The questionnaires received were forty (18 Architect, 11 Civil-Structural Engineers, 7 Mechanical Engineers & 4 Electrical Engineers).

Interviews with project managers for (4) selected major projects in Iraq had been performed to figure out the level of detailing and the benefits of BIM application in these projects.

5. DATA COLLECTION, ANALYSIS, AND RESULTS

As per the research methodology, the data collection and analysis process of this research is presented in Figure 3. According to the interviews that had been conducted with BIM specialist and practitioners, it had been noted that the adoption of BIM in major projects are limited to the following levels of detailing - (LOD): -

A- Design stage-(Consultant scope): - BIM100, 200, and 300 had been adopted in many projects at different levels for structural design, openings and finishes, and MEP design respectively.

B- Construction Stage-(Contractor scope): Shop drawings were achieved in some projects by updating the detailing to BIM400 level where materials from specified suppliers are inserted into certain levels. BIM models in the construction stage are utilized to solve contradictions and minimized requests for information-RFI raised by contractors which saves time.

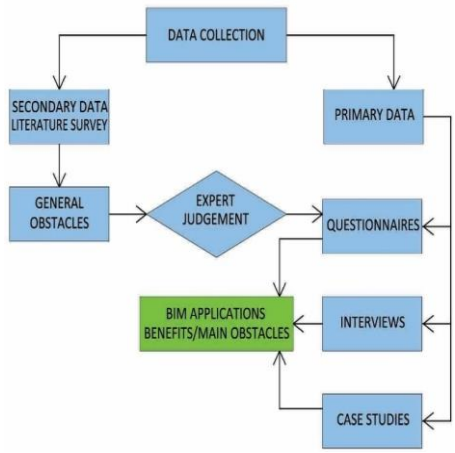

Figure 3. Data collection and analysis process for BIM application in major architectural projects

The insertion of project schedules and Cost estimates in the BIM model is rarely found in projects. Case studies are selected to explore BIM adoption status, benefits, and obstacles.

Based on the literature survey regarding the application of BIM especially in Iraqi projects, 21 factors affecting BIM adoption are extracted and sorted out under 4 main categories and as shown in Table 1. Following a discussion with BIM experts, it was concluded that these factors could be combined into seven main factors, which are represented in Table 2.

As stated in the methodology section, the designed questionnaires were collected from repliers, and data were processed in the SPSS program to get the "Relative Importance Index", the "Mean", and the "Standard Deviation' of each of the 7 factors.

The "Relative Importance Index (RII)" is used to determine the relative importance of quality factors identified in a project. The levels of influence and their weights assumed in the research are often linked to the five-point Likert scale and symbolized by the value of (W).

The Relative importance factor comes from (Frequency Index * Severity Index).

The Frequency Index is based on the frequency of occurrence as identified by the participants, whereas the Severity Index is the constant expressing weighting given to each response (ranges from 1 to 5) based on its severity as indicated by the respondents.

RII= $\frac{\sum W}{(A*N)}$ **(N)** is the total number of responses.

$$\mathrm{RII} = \frac{5(\mathrm{n5} + 4(\mathrm{n4}) + 3(\mathrm{n3}) + 2(\mathrm{n2}) + \mathrm{n1}}{5(\mathrm{n5} + \mathrm{n4} + \mathrm{n3} + \mathrm{n2} + \mathrm{n1})}$$

The "Mean" and the "Standard Deviation- SD" are additional indicators that are used to evaluate the significance of the variables. The following steps can be used to calculate them:

Mean Equation:

$$\overline{X} = \frac{\sum X}{N}$$

"$\overline{X}$ = Mean of all values in the data set",
"X = each value in the data set",
"N = number of values in the data set".

Standard Deviation Equation:

$$\mathrm{SD} = \sqrt{\frac{\sum (X - \overline{X})^2}{N-1}}$$

Based on the "Relative importance index (RII)" and the mean ranking analysis, the following extracted results show the importance of each factor in affecting the use and implementation of BIM in major projects in Iraq and in the sequential form:

(1) The Government and private institutions do not stipulate the application of BIM in the design and construction work of their projects (RII 85.50%); (2) The lack of sufficient knowledge of institutions, companies, and public and private organizations about what BIM is and how it is applied (RII 82.50%); (3) The absence of integrated local practices and applications for BIM that can demonstrate its feasibility (RII 79.50%); (4) The lack of contracts that take into account the characteristics of BIM applications in consulting services and construction and maintenance work (RII 76.00%); (5) The reluctance and hesitation of many consultants and contractors to the idea of switching to BIM (RII 70.00%); (6) The idea among many practitioners is that what BIM achieves is not very different from CAD and that the current supporting tools and software are sufficient (RII 66.50%); (7) The benefits of BIM application may not match the costs and time that institutions and companies need to apply BIM professionally (RII 59.00%).

Figure 4 shows the Relative Importance Index of each factor and Figure 5 shows the participants' percentages whereas, Figure 6 shows the Standard Deviation of each factor. It is used as a measure of the amount of "Variation or Dispersion" of each factor value.

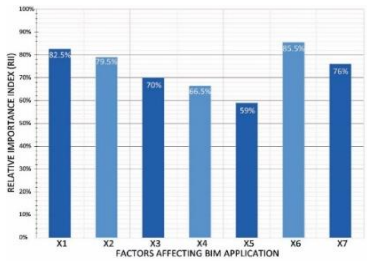

Figure 4. "Relative Importance Index" of the factors affecting BIM application

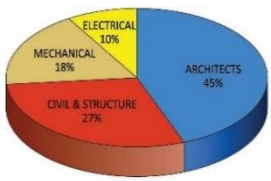

Figure 5. Participant percentages

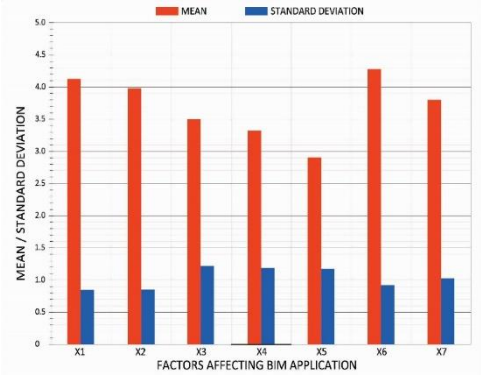

Figure 6. "Mean" and "Standard Deviation" of the factors affecting BIM application

Major projects in Iraq applying BIM are selected and meetings had been conducted with their project managers and consultants to get the BIM benefits and application status. The followings are the selected projects: -

A- Khatam Al-Anbiyaa Cardiac Diseases Hospital-Karbala (Figures 7, 8, and 9)

The project is in Karbala, plot area is 11,000 m^2, 11 floors with a total built-up area of 35,600 m^2, 150 beds, of which 60 rooms are ICU, CCU, 7 operating theaters, and 4 catheterization rooms.

Hospitals have several engineering systems, particularly this specialized type of hospital which need a high level of coordination. Client stipulated BIM adoption in design and construction works for this purpose and easy facilitation of future maintenance works.

In his reply to the question: "What are the benefits had been gotten from applying BIM in the Khatam Al-Anbiyaa Hospital Project in the design modifications and construction stage", the project manager replied that there are many benefits that can be summarized as follows: -

- More accurate design representations. Building cladding was possible to be modified easily.
- Visualization greatly improved a client's understanding of the building's design.
- When changes were made to the design, low-level rectifications were produced automatically.
- 2D Drawings can be produced at any point of the design process, and they were accurate and cohesive.
- Early collaboration between different design disciplines was decreasing waste brought on by inconsistencies in design between disciplines.
- Medical equipment, medical gases, nurse call systems, and furniture were properly coordinated with all other engineering systems and elements. Discrepancies were captured through BIM.
- Quantities were estimated at any design stage after BIM had been approved.
- Reduce rework, which shall help in reducing the remaining project's time.
- Minimize construction delays by synchronizing the design and construction phases.

Figure 7. Khatam Al-Anbiyaa Cardiac Hospital-Main Building-3D

Figure 8. Intensive care unit- ICU room

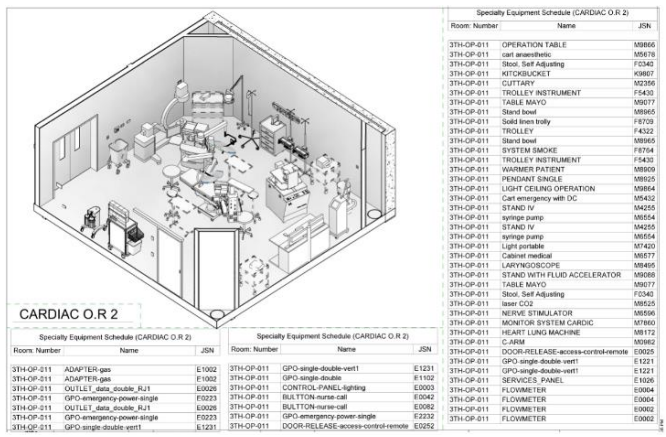

Figure 9. Cardiac operation room

B- Karbala International Airport Project (Figures 10 and 11)

It is a significant project which is expected to influence people's life, business, and area development. The design process for the terminal building is going on under the BIM umbrella for the sophisticated details it had been characterized with. Structure, divisions, curtain walling, false ceilings, and MEP services are all required to be coordinated.

The benefits had been obtained from the adoption of BIM as per the consultant are:

- Discrepancies and clashes were easily visualized and solved from the early stages of the design process.

- The client's and stakeholders' comprehension of the building's design was significantly enhanced by visualization.
- Reduce the number of adjustments by coordinating the design and construction processes to minimize construction delays.
- Easy customization for external façade cladding panels which are sophisticated and have a dynamic form.
- Predetermined sequential construction concerns.

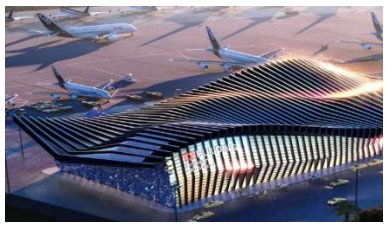

Figure 10. Karbala international airport project

Figure 11. Terminal B. Façade Design

C- Central Bank of Iraq- CBI (Figures 12 and 13)

Figure 12. Central Bank of Iraq

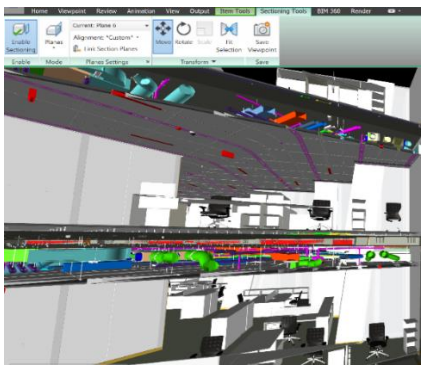

Figure 13. Mechanical Systems coordination under BIM

This is a major project that is anticipated to have an impact on businesses, the surrounding environment, and the city skyline. The construction process is currently taking place under the BIM framework. Coordination is necessary for the structure, internal divisions, external cladding, false ceiling forms, and MEP services.

The following advantages have been attained due to the adoption of BIM:

- Improved information flow enabled the project manager to perform proper coordination and documentation.
- BIM adoption was very much helpful in customizing the building skin form where the cladding panels are complicated in their forms and curves.
- Information flow was increased, errors were reduced, approval rates were enhanced, and change orders were decreased as a result of coordinated information and documentation.
- Minimize the amount of abortive work, which will have a positive impact on the time and cost of the project.

D- The Council of Ministers (Figure 14)

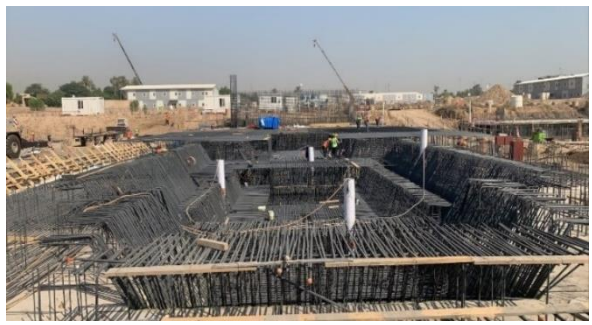

Figure 14. The Council of Ministers –Foundation Design-Construction

The contracting company is currently working on reproducing the detailed design and shop drawings under BIM with the following advantages:

- Dynamic form of the building and the different floor layouts had been perceived and controlled in detailing by BIM.
- Quick response to design modifications.
- Discrepancies were solved in the design stage which is expected to result in fewer RFIs on-site and saving considerable time accordingly.

6. CONCLUSIONS AND RECOMMENDATIONS

Integrated BIM application along the project life phases and by all stakeholders and parties can assist in time and cost enhancement.

Building information modeling (BIM)" has positioned itself as a vital tool and process enabler in modern architecture, engineering, and construction (AEC). Based on digital technology, BIM allows for more effective planning, delivery, and administration of physically constructed assets. BIM has helped the building industry overcome many obstacles. Implementing BIM requires undeniable change as adoption will not be easy and companies that have started implementing BIM still struggle with fundamental issues of how to re-establish the workflow, train employees, and define responsibilities for the modeling process.

Therefore, education and awareness of what BIM is and its tools and techniques are very important to address resistance to change. BIM offers measurable advantages that can much outweigh the associated application expenses. It is challenging to quantify the cost and value of adopting BIM. Additionally, adopting BIM has many intangible advantages, making it more challenging to determine the return on investment.

Due to the technology's rapid expansion, there are not enough professionals to fill the positions offered. Finding professionals with the necessary experience is an issue with BIM. Despite how enticing the advantages of BIM could be, different countries have different adoption rates. According to earlier studies, the majority of developed countries are implementing and using BIM more frequently. In contrast, developing countries continue to adopt BIM slowly.

Although many projects have used BIM tools to speed up or cut costs in diverse ways, not all of them necessarily have gained from this. Application of the newest technology in the design and construction phases may cause delays on some projects unless a proper setting, the right resources, and organization have been made available in the client, consultant, and contractor firms.

BIM application is in its primitive stages in Iraqi major projects and needs to be performed in a complementary cycle of design and construction as such projects are in necessary need of these application levels concerning the schedule, cost estimate, facility management, and maintenance issues.

- Both BIM users and the AEC sector should be aware that complete integration of BIM provides the biggest and most tangible advantages.
- When stipulating BIM, the BIM environment must be integrated, starting from the design by a consultant to the construction by a contractor. This means that the contractor must be able to deal with the design deliverables under BIM and complete the shop drawings and submittals according to BIM as well.
- More studies can be done when the complementary cycle of BIM has been exercised actually in Iraqi major projects whereby measuring the benefits of BIM can be done based on many parameters such as: studying its impact on project schedule, cost, change orders, claims, defects, energy waste, product quality, request for information, return on investment, risk, and safety.
- There are some attempts to activate BIM in some Iraqi institutions, including the Ministry of Health, which decided to require the application of BIM by the consultant through RFP for the proposed hospitals, but this was not effectively activated.
- The research has concluded seven obstacles against BIM application in major Iraqi projects, on top of them is the absence of mandatory stipulations from clients and owners to implement BIM in the design and construction of projects.
- Training engineers of government and private institutions to use BIM, especially in major projects.
- Adopting BIM 360 is advised to support informed decision-making since it is a single platform that links the project teams and data in real-time, from design through construction. BIM 360, a cloud-based Autodesk solution, enables project teams to collaborate successfully.
- This study was limited to engineers, practitioners, and project managers, who have experience in using BIM applications in major projects' design and construction management in Iraq, which encompass drawings production, detailing, planning, time scheduling, and cost estimating.
- Further research is required to find out the role of BIM applications in mitigating complexity and risk impact in major architectural projects. Moreover, it is recommended to study the contribution of BIM in creating "Design Value" beyond the physical benefits of scope, time, and cost.

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